Claims

[1] 1. A three-dimensionally networked silica composed of silica particles of 0 to100 nm combining by bridge chains of aliphatic, aromatic, polyimine, peptide, and polyether groups.

2. A three-dimensionally networked silica according to claim 1, wherein the length of bridge chains is ranged in 0.5 to 100 nm.

3. A three-dimensionally networked silica according to claim 1, wherein the content of bridged chains per silica is ranged in 0.1 to 1.5 mmol/g.

4. A three-dimensionally networked silica according to claim 1, wherein the combining reactions are carried out in toluene, xylene, octane, butanol as solvents at 40 to 150°Cwith refluxing.

5. A three-dimensionally networked silica according to claim 1, wherein silica particles are combined by reacting silane-coupled silica particles coupled with trialkoxy silane having an amine substituent and another silica particles coupled with trialkoxy silane having a glycidyl substituent.

6. A three-dimensionally networked silica according to claim 5, wherein the reacting pairs are amine and chloride, glycidyl and mercapto, glycidyl and hydroxyl, and amine and mercapto groups.

7. A three-dimensionally networked silica according to claim 5, wherein the coupling reactions between silica particles and silane and between silane-coupled silica particles are carried out in toluene by refluxing.

8. A three-dimensionally networked silica according to claim 5, wherein the silane having an amine substituent is 3-aminopropyltriethoxy silane and the silane having a glycidyl substituent is 3-glycidoxypropyltrimethoxy silane.

9. A three-dimensionally networked silica according to claim 5, wherein the silane having an amine substituent is 3-aminopropyltriethoxy silane and the silane having a chloride substituent is 3-chloropropyltrimethoxy silane.

10. A three-dimensionally networked silica according to claim 5, wherein the silane having a mercapto substituent is 3-mercaptopropyltrimethoxy silane and the silane having a chloride substituent is 3-chloropropyltrimethoxy silane.

11. A three-dimensionally networked silica according to claim 5, wherein the silane having a mercapto substituent is 3-mercaptopropyltrimethoxy silane and the silane having a glycidyl substituent is 3-glycidyloxypropyltirmethoxy silane.

12. A three-dimensionally networked silica according to claim 1, wherein silica

particles are combined by reacting silane-coupled silica particles with connecting materials with multifunctional groups on their ends in toluene by refluxing.

13. A three-dimensionally networked silica according to claim 12, wherein the connecting materials are diamines, dichlorides, diisocynates and dicarboxylic acids with methylene chains of C_6-C_{100}.

14. A three-dimensionally networked silica according to claim 12, wherein silica particles are combined by reacting silica particles with dichlorides having methylene chains of C_6-C_{100} in toluene by refluxing.

15. A three-dimensionally networked silica according to claim 12, wherein connecting materials are diisocyanato having methylene chains of C_6-C_{100}.

16. A three-dimensionally networked silica according to claim 12, wherein the silane having an amine substituent is 3-aminopropyltriethoxy silane and the connecting material is dichloro, dibromo or diiodoalkane with the methylene skeletal of C_6-C_{40}.

17. A three-dimensionally networked silica according to claim 12, wherein the silane having an mercapto substituent is 3-mercaptopropyltrimethoxy silane and the connecting material is dichloro, dibromo or diiodoalkane with the methylene skeletal of C_6-C_{40}.

18. A three-dimensionally networked silica according to claim 12, wherein the silane having a glycidyl substituent is 3-glycidyloxypropyltrimethoxy silane and the connecting material is diamino or diisocynato alkane with the methylene skeletal of C_6-C_{40}.

19. A three-dimensionally networked silica according to claim 12, wherein the silane having a glycidyl substituent is 3-glycidoxypropyltrimethoxy silane and the connecting material is polyethyleneimine with molecular weight 600-30,000.

20. A three-dimensionally networked silica according to claim 19, wherein the skeletal of connecting materials is polyether of C_6-C_{50}.

21. A three-dimensionally networked silica according to claim 1, wherein silica particles are combined by reacting, silica particles are directly reacting multi-functional connecting materials in toluene by refluxing.

22. A three-dimensionally networked silica according to claim 21, wherein the multifunctional connecting materials are dichlorides with the methylene skeletal of C_6-C_{40}.

23. A three-dimensionally networked silica according to claim 21, wherein the multifunctional connecting materials are diisocyanates with the methylene

skeletal of C_6-C_{40}.

24. A three-dimensionally networked silica according to claim 5, wherein the non-reacted amine groups are inactivated by reacting with chloroalkane with C C_{12} in toluene with refluxing.

25. A three-dimensionally networked silica according to claim 5, wherein the non-reacted amine groups are inactivated by reacting with monochloro or dichloro acetic acid.

26. A three-dimensionally networked silica according to claim 5, wherein the non-reacted glycidyl groups are inactivated by reacting with aminoalkane with C $_4$-C_{12} in toluene with refluxing.

27. A three-dimensionally networked silica according to claim 6, wherein the non-reacted chloride groups are inactivated by reacting with aminoalkane with C $_4$-C_{12} in toluene with refluxing.

28. A three-dimensionally networked silica according to claim 1, which is an additive with 5 to 100 phr to reinforce tensile and mechanical properties of rubber compounds composed of zinc oxide, stearic acid, curative accelerator, activator, processing oil, stabilizers and retarder.

29. A three-dimensionally networked silica according to claim 28, which is an additive for rubber compounds composed of diene rubber, natural rubber, butadiene rubber, styrene-butadiene rubber and butyl rubber as base rubber.